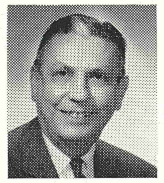
OHIO BRASS MANAGEMENT REPORT

It's the iceberg below that makes the difference

BY ROGER A. BLACK
PRESIDENT, OHIO BRASS COMPANY

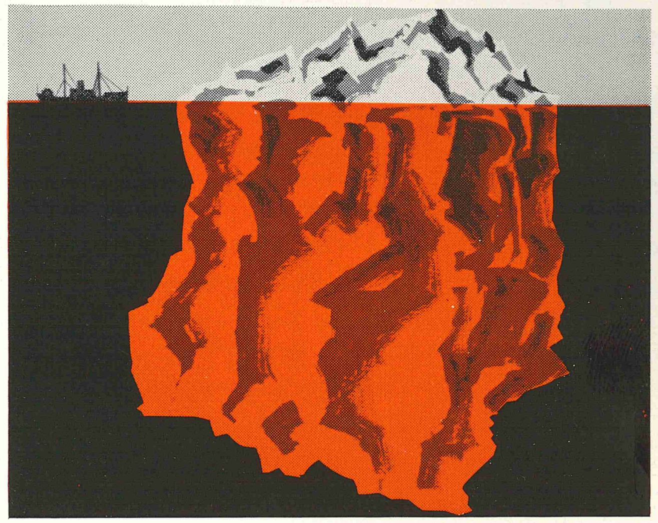


Granted that every executive doesn't know everything about his company, I still had some pleasant surprises in reading the January issue of *Hi-Tension News*, the publication which Ohio Brass sends to its utility customers and prospects. The issue describes the O-B High Voltage Laboratory in detail. Of course, the four-million-volt, all-weather surge generator and the new voltage divider get considerable attention. But it goes beyond the glamour equipment and crash testing programs to talk about behind-the-scenes activity that has both human and technical interest.

IT DESCRIBES A BRAND-NEW oscilloscope being benched and rewired simply because there are no available 'scopes that meet the present needs of the laboratory for measuring conditions that have never been measured before. *Hi-Tension News* notes the presence of a full-time machine shop in the laboratory basement. Often a prototype under test has to be modified on the spot so that an expensive test set-up doesn't stand idle.

THE ISSUE DISCUSSES the problem of finding personnel to maintain our five surge generators. Just like suitable oscilloscopes, they aren't available in the market place. We must train our own, and we need a graduate engineer to supervise the job.

IN OBSCURE CORNERS of the laboratories all kinds of seemingly simple tests go on . . . insulators live in a highly polluted atmosphere with leakage currents being continuously recorded . . . an isolation chamber tests hardware ability to stand up in a highly corrosive atmosphere.



WE EVEN HAVE our special brand of photography with a laboratory staff photographer who has developed special techniques for recording flashovers so that our customers can see in photographs what goes on when their projects are tested . . . better than their own eyes can do the job.

OUR HIGH VOLTAGE LABORATORY has been compared to an iceberg. Showing above the surface are spectacular equipment and glamourous testing. But it's the eight-ninths below the surface that contributes even more to meaningful results. If you would like to know more about the iceberg below, I'll be glad to send you a copy of our January *Hi-Tension News*.

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OHIO BRASS COMPANY • MANSFIELD, OHIO
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OHIO BRASS

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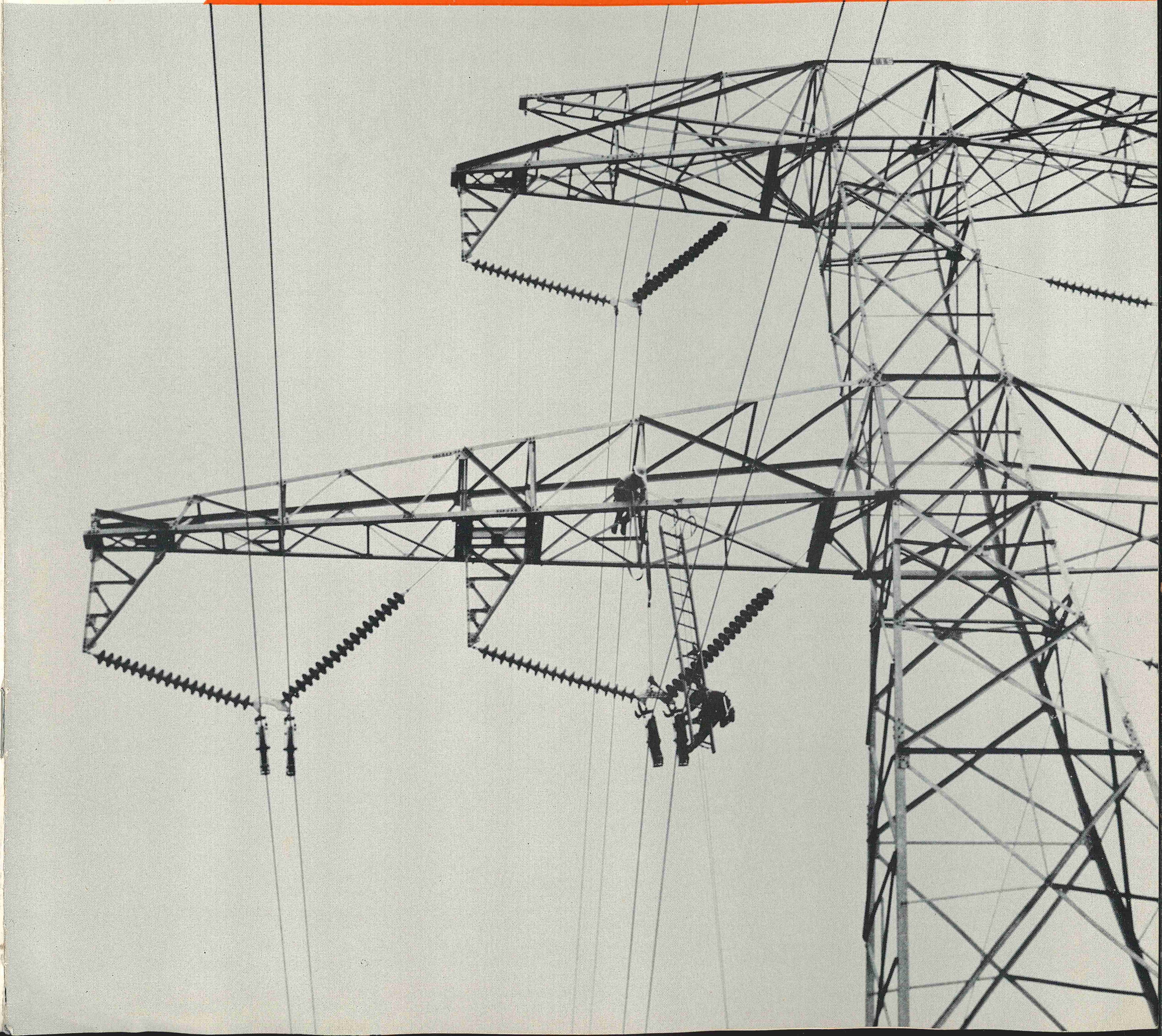
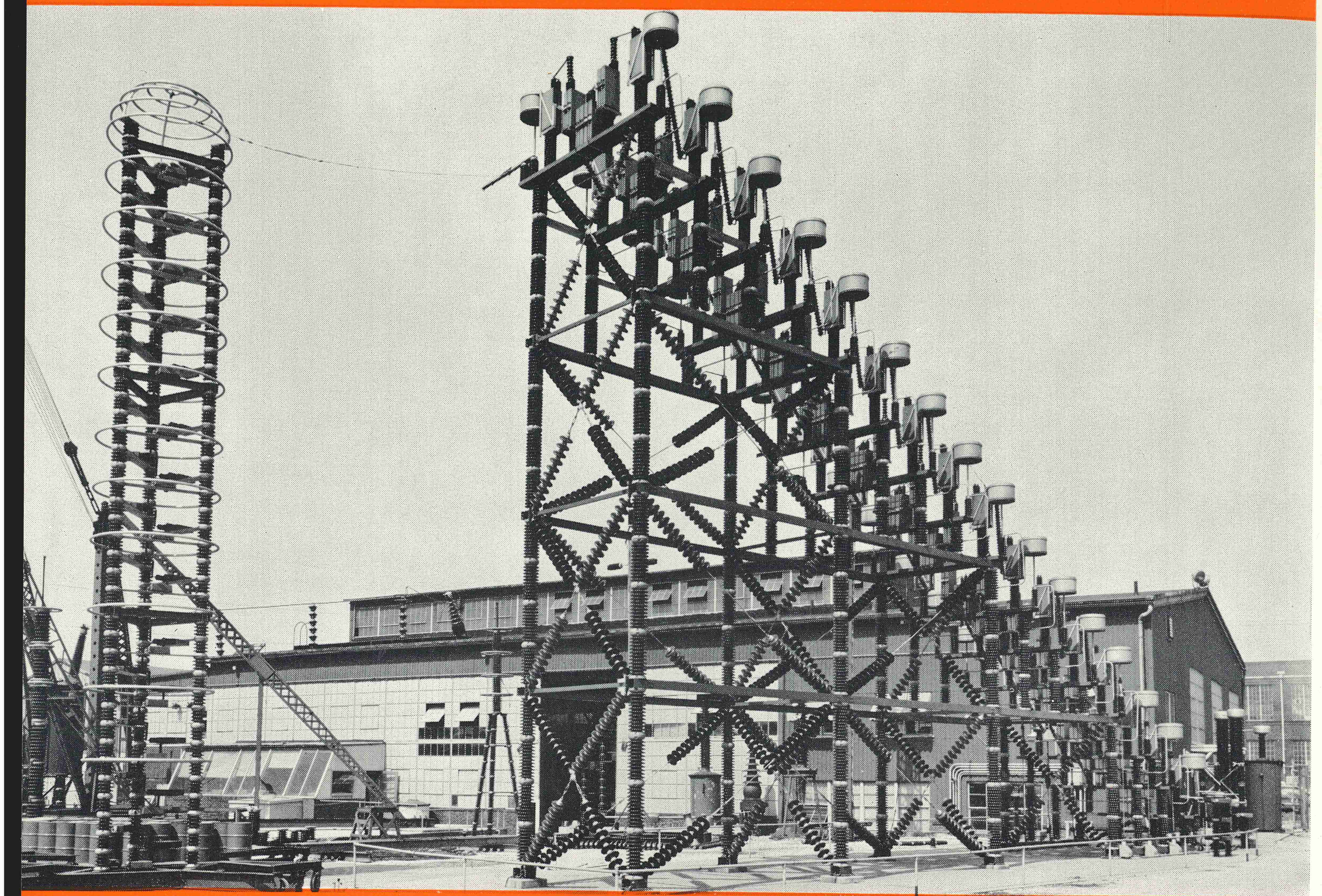
Hi-Tension News

MARCH 1966





▲ O-B's new 4,000-kv surge generator. This fully exposed equipment operates perfectly . . . unprotected . . . in any kind of inclement weather, giving realistic test results on full-scale line prototypes, in a natural climatic environment. At the left is the 50-foot-high capacitance voltage divider.

EDITOR'S NOTE: In several recent discussions of the O-B High Voltage Laboratory, some description has been given of the new all-weather 4,000-kv generator for the production of switching surges and lightning discharges. Because of space restrictions, these were somewhat brief and incomplete. They have awakened considerable interest among engineers, however, and we have been asked if we could treat this new piece of equipment in somewhat more detail. As one man put it, "I'd like to know enough about it so I could build one in my basement."

Therefore, we are presenting here some of the more intimate facts of this generator, and simply comment it would be quite a basement full!

O-B Hi-Tension News
Mar. 1966, Vol. 35, No. 3

ON THE COVER - Linemen install regular O-B controlled-radius suspension clamps at a light angle position on a new midwest 345-kv transmission line. Use of clamps at tangent, angle, and deadend positions simplifies EHV construction and gives linemen a standard installation procedure.

OHIO BRASS CO., MANSFIELD, OHIO

New generator for switching surge studies has 187.5-kilojoule output at 4,000 kv

Because of the importance of switching surges in modern EHV transmission, the O-B High Voltage Laboratory has given high priority to their study.

First, these surges must be realistically produced on laboratory equipment. This is not entirely a simple order. Switching surge wave shapes are unconventional in terms of ordinary impulse discharges, being in the order of 100 to 300 by 3,000 to 5,000 microseconds. Voltage capability must be quite high. Surges can run from 2.5 to a possible three times nominal system line-to-ground voltage. For testing purposes, a laboratory should be able to exceed the maximum materially. Therefore, an assumed test project involving a proposed million-volt line calls for a powerful generator.

Since surge phenomena necessitate detailed analysis and study, accurate data is a prime requisite and demands highly refined control and instrumentation.

These are a few of the criteria that were carefully explored during the specification stage of O-B's new generator for the production of high-voltage switching surges. The result is at present the industry's most sophisticated piece of equipment of this type.

Many engineers have asked for details of this generator. It follows the textbook Marx circuit, where capacitors are charged in parallel and discharged in series. Physically, it consists of 16 banks. Each bank comprises 12 capacitors arranged in pairs; each pair is connected in parallel, and the six resulting combinations are series connected. This totals 192 capacitors.

Since O-B is in the capacitor business, it was quite practical to design and build custom equipment for this purpose. Standard 100-kvar single-bushing cases were used to house internal packs specifically intended for impulse duty. Each capacitor is rated at 41.7 kv/1.125 microfarad, resulting in a combined value of .0234 microfarad at 4,000 kv. A special tab connection was devised to withstand the high currents resulting from specimen flashover occurring on impulse flashover tests. Oversize bushings were specified for increased insulation and leakage current resistance.

The two center pairs of capacitors in each bank are mounted directly on the steel framework, while the four outer sets are supported on post insulators. Charge resistor connections are made to the mounting racks supporting the outer sets of capacitors. The series connection between outside sets of each bank is made through a porcelain-housed resistor. This is non-inductive, and consists of bifilar-wound nichrome wire on an epoxy glass tube encased in an oil-filled housing. These resistors are mounted vertically on a short paralleling bus on top of the capacitor bushing. Many of these details can be seen in the accompanying illustrations.

Before discussing gaps or insulation, the most unique feature of this new generator must be appreciated. It is a permanent structure in the outdoor section of the laboratory, fully exposed to the weather. This tends to violate certain basic concepts of a surge generator. In the course of charging, the air space between the many sphere gaps becomes highly stressed, and the passage of a raindrop, snowflake, or other air-borne particles through this space can trigger a premature discharge. This would make the equipment erratic and probably inoperable. To impart all-weather

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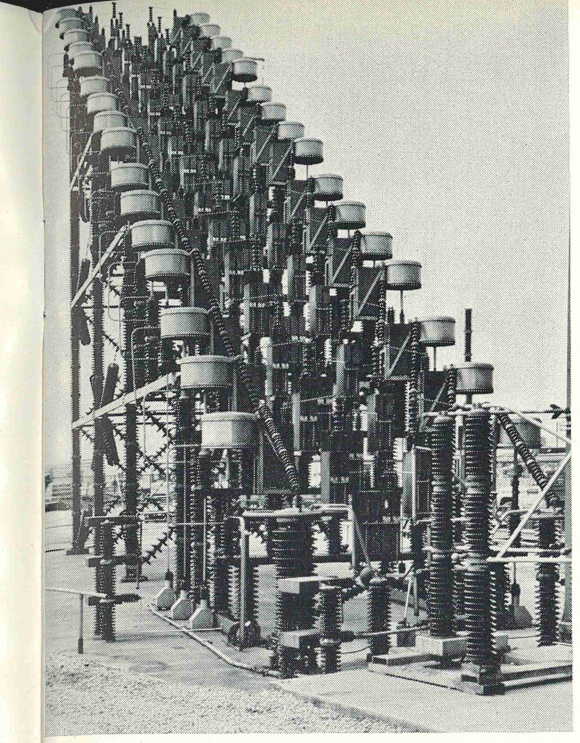
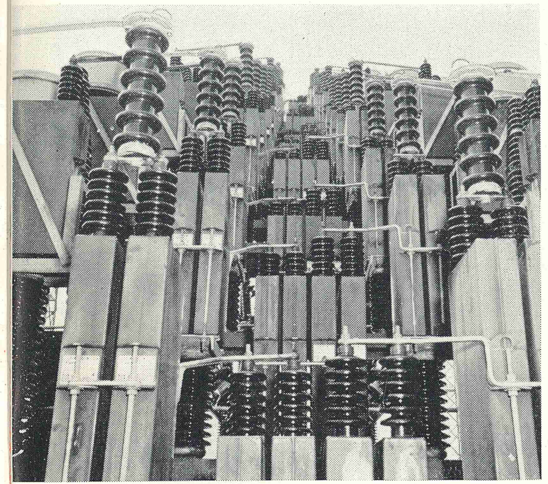
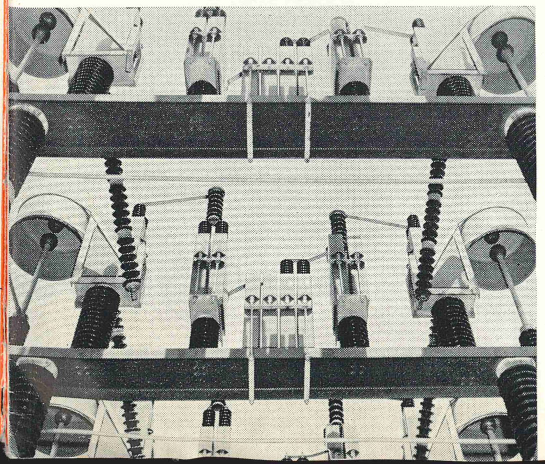


Looking up the "backbone" of the new generator. Arrangement of components is well illustrated.



Some of the 192 special impulse capacitors built in the O-B plant for the new generator.

Complete 250-kv bank, showing the 12 capacitors, series resistors, charge resistors, and shrouded sphere gaps.



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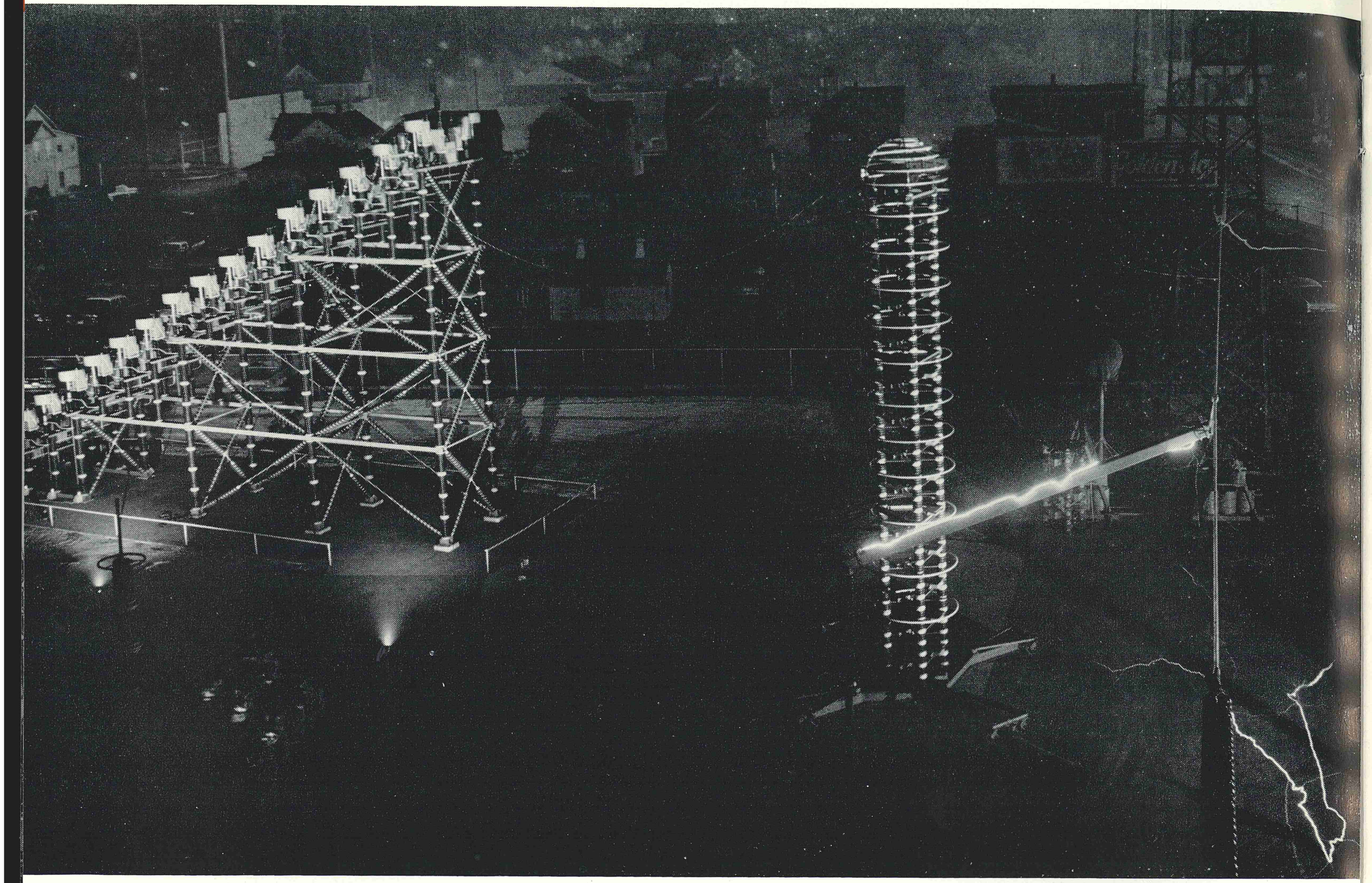
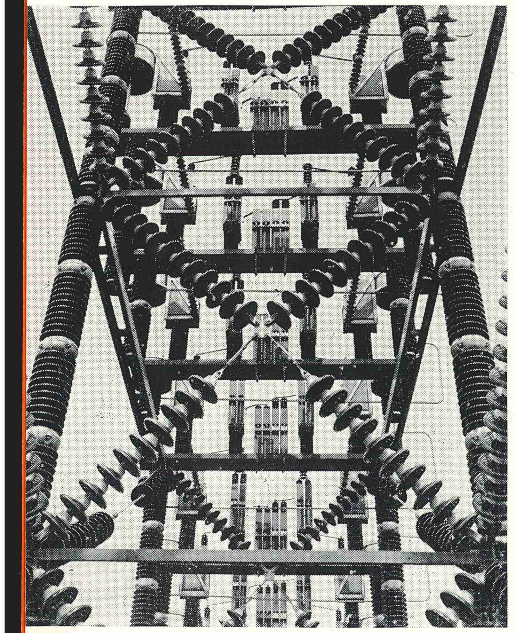


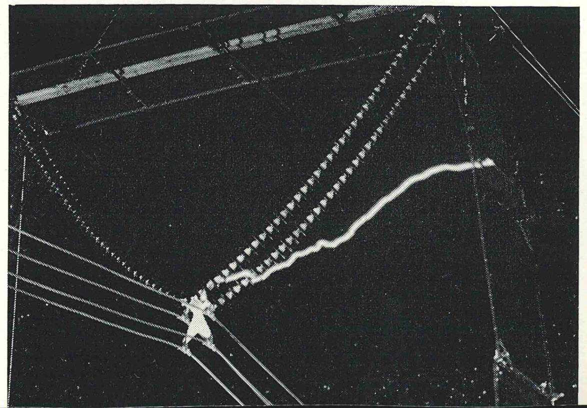
A dramatic test picture of a switching surge discharge over the insulating arm of a Holan aerial elbow. Length of the flashover path is 23 feet. The generator was performing at about one-half maximum output.



◀ Insulation of the generator must withstand switching surges under wet, and possibly contaminated, conditions. Some of the critical insulating members under d-c voltage during charging are silicone protected.

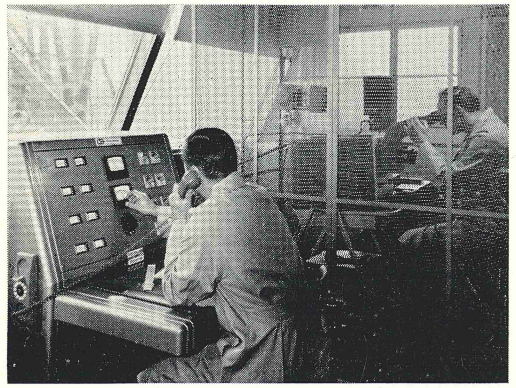
Capacitance voltage divider containing 40 units of 80 kv / 10 microfarads each. This device facilitates precise control of switching surge wave forms and presents a clear signal to observation and recording instruments. ▶

Switching surge discharge produced during laboratory studies on a 735-kv transmission system.



operation, all gaps are housed in deep protective shrouds that have proved entirely effective in the course of some 75,000 shots that have been conducted in every degree of inclement weather.

Each bank employs two sphere gaps in series to obtain a rating of 250 kv. No resistance grading is used to divide the voltage across the gaps. The series-connecting bus is at a phantom ground potential during charge and the capacitances thus involved provide adequate grading. Adjustable gaps are used in the first 1,000-kv section. The other three 1,000-kv sections employ fixed gaps. Gap adjustment is performed by an insulated rod driven by a linear actuator.



Control room for the outdoor test yard. The operator at the console directs settings and firing of the 4,000-kv surge generator and is in direct telephone communication with personnel in the test area. In the background a technician is making readings on the special photographic oscilloscope which is housed in an interference-free enclosure.

Because the outdoor section of the O-B High Voltage Laboratory is exposed to severe industrial fallout and chemical contamination, the insulation of the surge generator structure was designed to withstand wet switching surge voltage at maximum rated output. It will be seen that elaborate insulation is employed and the insulation under d-c voltage during the charging period is protected by silicone.

Past references have revealed that the rated voltage of this new generator is 4,000 kv. Since it is outdoors where space is not at a premium, this rating can be increased to 6,000 kv if ever required. Voltage, however, is not the only criterion of this device. Energy output is 187.5 kilojoules (187,500 watt-seconds). The discharge of this energy into the arc of a flashover and the internal resistance of the generator, within ten microseconds, will dissipate power at the average rate of approximately 20,000 megawatts. This is about ten times the continuous power rating of the new Robert Moses Power Plant at Niagara Falls, New York.

In order to accomplish precise control of switching surge wave forms, and to provide a proper signal to sensitive reading and recording equipment, a 50-foot-high capacitance voltage divider is a companion piece to the surge generator. This is comprised of 40 capacitors with ratings of 80 kv/10 microfarads each. Connected in series, this produces a combined value of 2,500 micro-microfarads at 3,200 kv.

In order to be moved in and out of tests, and to be placed at optimum locations, the voltage divider is supported on a large wheeled framework that permits positioning on any part of the concrete pad of the outdoor test yard. Both the divider and generator have been designed for stability in winds up to 100 mph.

All adjustments and firing orders for the surge generator come from a console in the glass-enclosed control room of the outdoor test yard. Since this may be some distance from the test specimen, the operator is in direct telephone communication with personnel in the yard, not only for safety, but to obtain flashover data that may come from closer observation. Also housed in this control room is a specialized photographic oscillograph within an enclosure totally shielded from extraneous electrical interference.

Facilities of the laboratory permit a somewhat unusual hookup for special test requirements. Within the laboratory building is another 3,000-kv research surge generator. This is also equipped with a capacitance voltage divider. This generator may be moved on tracks to the outdoor section. When needed, the two generators can be synchronized and fired at opposite polarity. Naturally, this capability is limited in its use to certain phase-to-phase conditions and is not considered a normal routine test procedure. In special cases, however, simultaneous opposite-polarity output surges can be produced. They are recorded on two separate oscilloscopes, synchronized by using a common sweep tripping pulse.

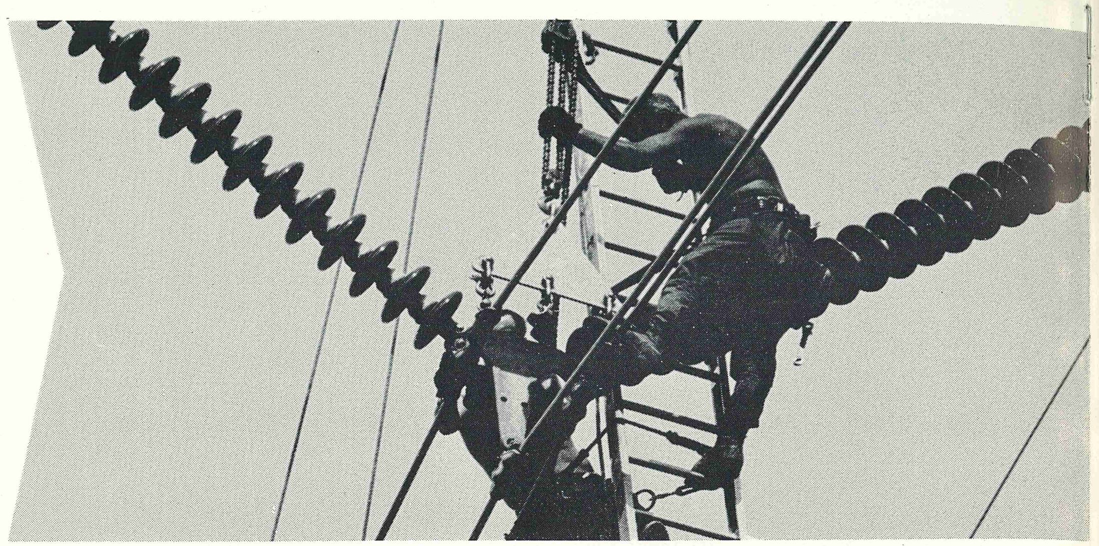
By means of the new 4,000-kv surge generator, the O-B High Voltage Laboratory can apply realistic switching surge voltage to full-scale line prototypes, in an outdoor location exposed to natural climatic environment. Test results have the advantage of being highly authentic and dependable.

But this may possibly take second place in over-all value. By being able to produce and control a broad spectrum of switching surge magnitudes and wave forms, and make accurate, detailed observations, a constantly increasing fund of knowledge is being accumulated on this important phase of EHV transmission. And it is such knowledge possessed by capable people that is the really priceless asset of a scientific institution.

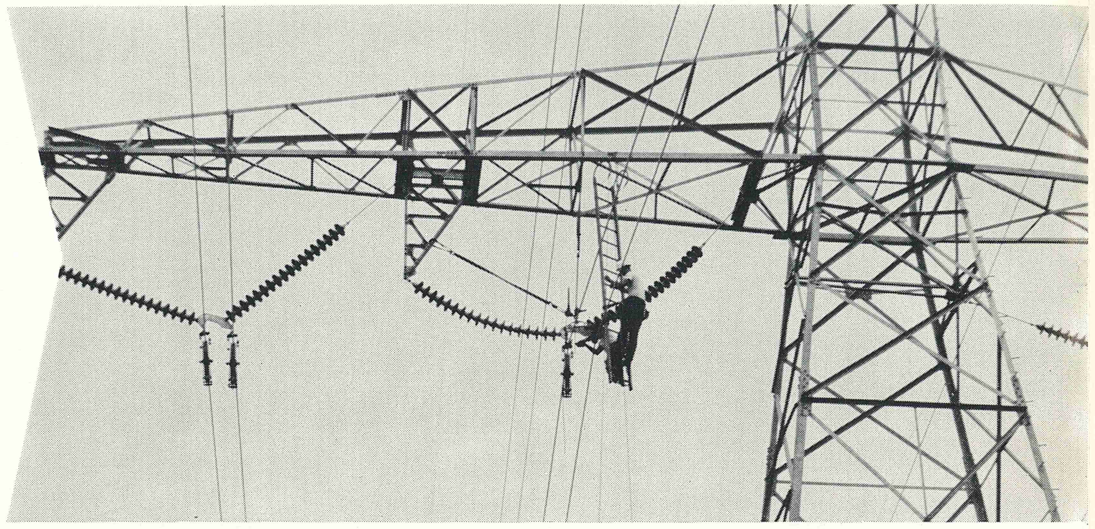
Among other details of this new generator and its allied equipment, we have avoided mention of its cost. Even with many components available through our own manufacture, such equipment represents a major expenditure. This can be justified only in terms of usefulness. Power companies with proposed EHV projects, and faced with the need for reliable projections of operating performance, are cordially invited to use these facilities. May we place them at your disposal?

Simplify construction of . . .

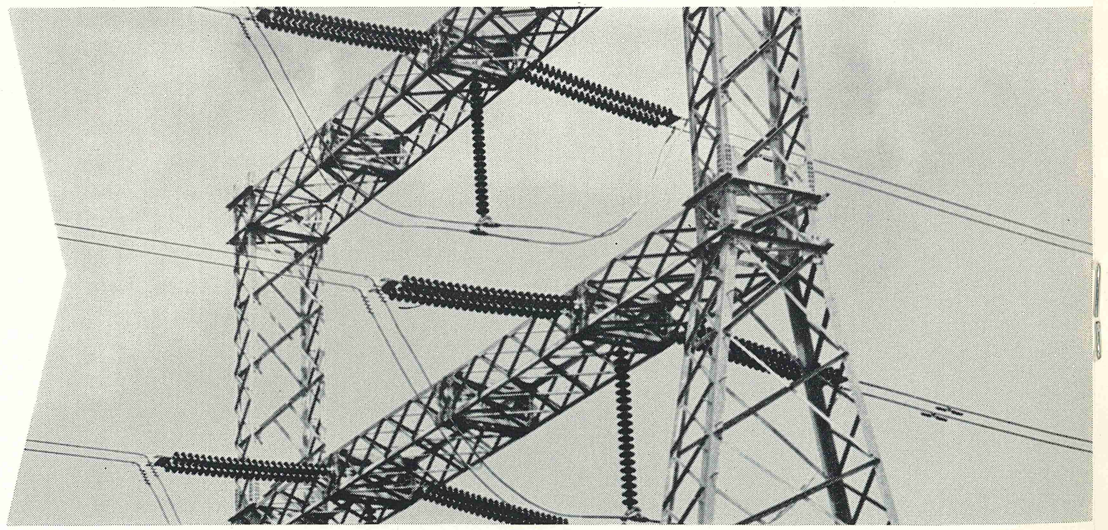
. . . Tangent



. . . Angle



. . . and Deadend Positions



Let O-B Suspension, Angle, and Strain Clamps Support Your Transmission Line

String and tension your conductor bundle, then CLAMP your conductors securely into place with O-B transmission-line clamps. O-B offers three types of custom-designed clamps to support all positions on your transmission line -- including EHV. All three clamps -- suspension, angle, and strain -- are cast to assure consistent reproduction of the smooth contours and controlled-radius design.

Selection of clamps to match your line's exact performance characteristics at tangent, angle, and deadend positions requires a critical analysis of your specifications. With your anticipated loading conditions and conductor size, the O-B development engineer begins adapting one O-B controlled-radius clamp for each type of position. First, he determines the three most critical clamp dimensions -- the correct distance from the centerline of the cotter bolt to the centerline of the conductor, over-all clamp length, and the seat-approach angle. Controlled-radius design and modern casting manufacturing enable the O-B engineer to develop the optimum clamp size and shape and be assured of accurate design reproduction during manufacture.

With the individual clamp bodies determined, the keeperpiece is selected for correct fit between conductor and clamp. All O-B keeperpieces are designed to fit the specific conductor size employed. Close fit between conductor and clamp prevents possible lateral movement, and assures even distribution of keeper pressure to protect conductor strands from distortion.

Installation of O-B transmission-line clamps is convenient and simple. One socket wrench is the only tool required to make fast, secure attachment of clamp to conductor. O-B's corona-control suspension and angle clamps use four captive, inverted keeper bolts to take advantage of gravity and aid installation of nuts and lock washers. O-B's quadrant strain clamps employ U-bolts to secure the keeperpiece -- in combinations of three, four, five, or six bolts per clamp.

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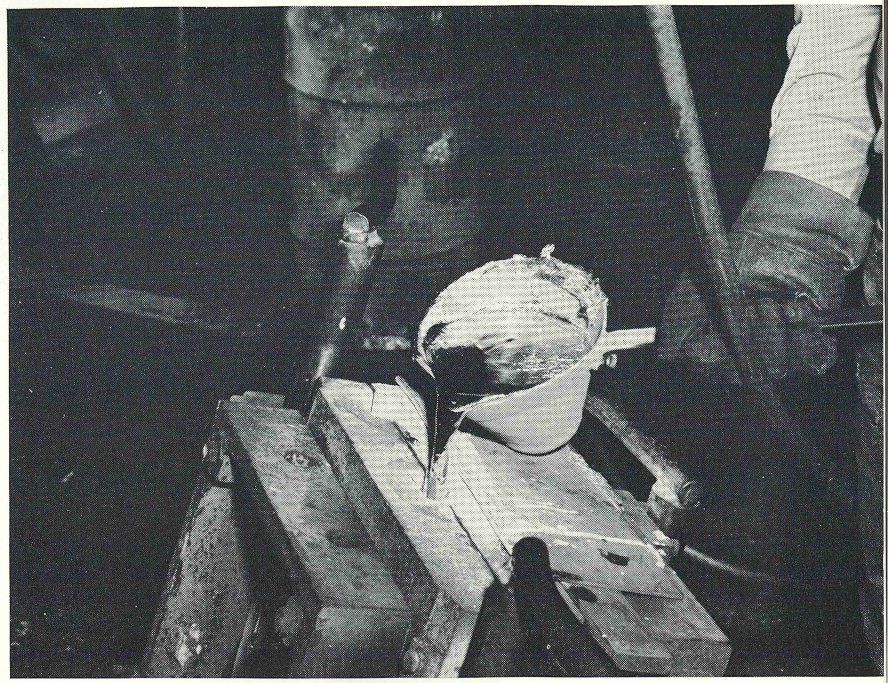
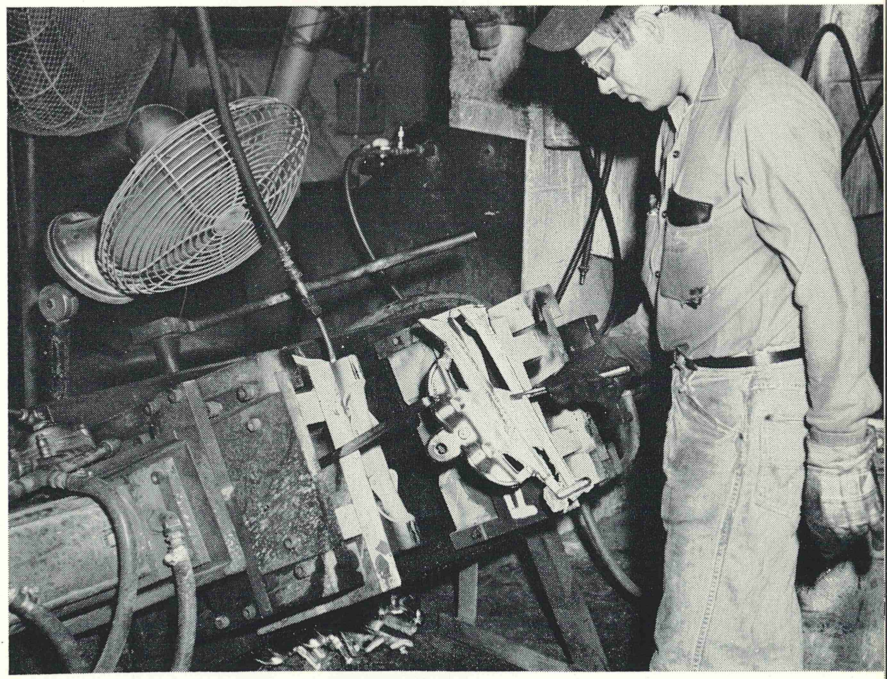
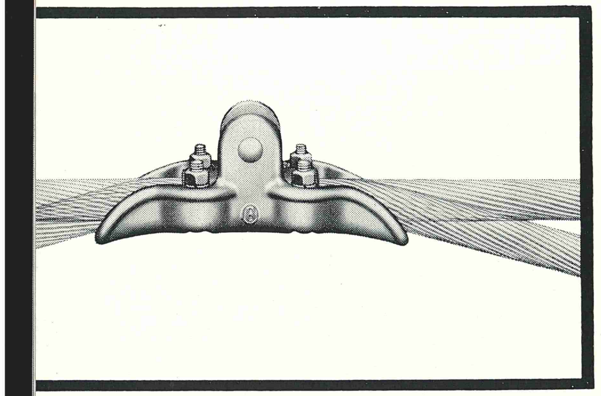


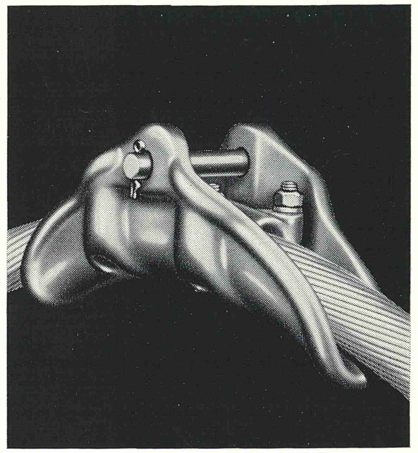
Precise casting of all O-B clamps assures faithful reproduction of the controlled-radius design for a close fit with the conductor and maximum protection at the support point.

Steel permanent molds furnish a consistent design reproduction time after time and produce a casting with uniform metallurgical structure throughout.



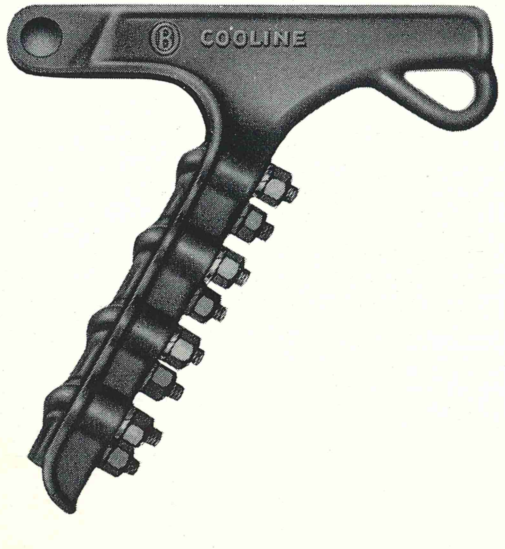


Tangent construction and angles up to 30 degrees are applications for O-B's corona-control suspension clamps -- custom designed for your loading requirements and conductor size.



O-B angle clamps help form the conductor over a smooth continuous-radius surface at angle positions and furnish a generous allowance for increased loading during thermal or mechanical cycling.

Linemen construct a strong, secure continuous-loop deadend with O-B quadrant strain clamps using only a single socket wrench. Strengths from 10,000 to 36,000 pounds are available in malleable iron, bronze, and aluminum.



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Loose parts and tools required at the tower top are kept to a minimum with O-B clamps, and linemen need no special training to make a fast, permanent, and correct installation.

O-B's corona-control Cooline(R) suspension clamps support tangent construction and angle positions up to 30 degrees. Generous blending off of the clamp edges and lip protects the conductor during mechanical displacement to prevent kinking or binding across the clamp. Each clamp is designed with a built-in protective margin across the clamp-body radius to accommodate the varied vertical loading requirements encountered on your line. Controlled distribution of metal during manufacture results in a custom-fit cradle with metal cast exactly at load application points for optimum performance and strength-to-weight ratio.

Electrically, O-B suspension clamps are compatible with associated line hardware -- even without control rings. O-B's corona-control clamps are specially designed for application above 345,000 volts, employing rounded edges and smooth-finished surfaces to eliminate possible projections which might serve as a stress point at elevated voltages.

Casting of O-B corona-control aluminum suspension clamps in steel, permanent molds assures consistent manufacturing quality and faithful design reproduction time after time. Controlled cooling and heat treating result in uniform metallurgical structure throughout the clamp for maximum strength. Use of aluminum also eliminates the possibility of power losses resulting from the magnetic field surrounding the suspension clamp.

For angles in excess of 30 degrees -- and as high as 60 degrees -- O-B's special angle clamps find ideal application. A continuous-radius clamp body helps form the conductor path across the angle and cradles it in a smooth-surfaced area. Controlled-radius design permits the O-B engineer to include sufficient allowances into the clamp, body radius to protect the conductor during abnormal loading. Thermal expansion or contraction, ice loading, or heavy wind induces lateral movement in the conductor, which increases the turning angle at the support point. The built-in allowance in O-B angle clamps permits the conductor to take up a greater surface area on the clamp seat. In effect, the increased loads are distributed over a broader area.

High strength is an inherent benefit in O-B angle clamps. All are cast of malleable iron or aluminum alloy, then combined with an aluminum keeperpiece. The malleable iron clamp body is hot-dip galvanized for assured long life.

Construction of deadends with O-B quadrant strain clamps furnishes distinct savings in time and construction material. First, the conductor can be formed in a continuous loop -- no splices. To install a complete deadend, your linemen need only relieve the conductor load from the insulator string, install the clamp, connect it to the insulator string, replace the load on the completed assembly, form the conductor loop, then repeat the clamp installation procedure.

Available in bronze, aluminum, and malleable iron, O-B strain clamps provide inherently good snubbing action to support the conductor load securely at the deadend. Strengths from 12,000 to 36,000 pounds are available to support almost any deadend position. Again, casting procedure permits control of internal and external finish during manufacture to assure maximum protection of the conductor stands.

Standardize your transmission line supports with clamps -- O-B clamps -- and simplify construction for your line crews. Save time, investment, and stocking costs, and have the security of proved performance when you install Ohio Brass suspension, angle, and deadend clamps. Over 10,000 miles of modern EHV transmission line have proved their on-line performance reliability. Your O-B district manager will be glad to show you samples and answer any questions. Call him now.

Repeat orders prove popularity of versatile Holan Bronco 83

In 1966, the most popular Holan aerial device may be the light-duty Bronco 83 -- a modest-sized aerial elbow with the built-in quality considered standard only on larger, more expensive units. Large numbers of new Bronco 83 elbows will be delivered to experienced and satisfied users, with many more scheduled for first-time delivery to utility people who have seen this strong, versatile unit in action.

Whichever group you are in, the major appeal of the Bronco 83 remains high performance -- assured by superior design features and a wide selection of options. And, Holan offers a full, one-year warranty on each Bronco 83 elbow.

Select a chassis as small as one ton for your new Bronco 83 and get the compactness to work in and out of tight places with ease and comfort. To this inherent maneuverability, add the ruggedness of the service-proved components employed on heavy-duty Holan elbows. Choose a 27-, 32-, or 36-foot, bucket-height model of the Bronco 83 and lift up to 300 pounds in any position. Furthermore, the 83 doubles as a derrick when a hydraulic winch is mounted on the lower arm -- lifting 1500 pounds at zero degrees and 6000 pounds at a 75-degree boom angle.

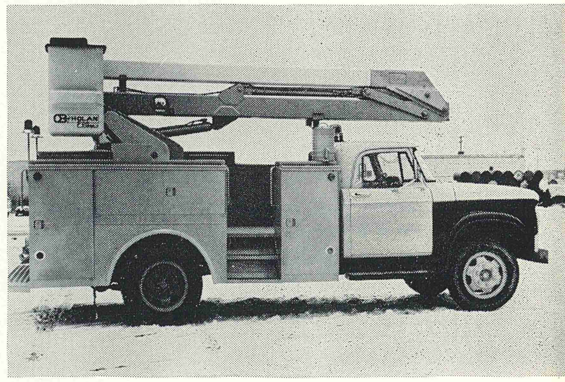
Continuous rotation in either direction and a three-foot reverse-offset superstructure give the Bronco 83 maximum aerial stability -- even when mounted on short CA vehicles. Use of a Holan-designed torsion-bar stabilizer system eliminates the need for auxiliary outrigger jacks, except on extremely rugged terrain.

Several equipment options available on the Bronco 83 further increase its versatility. A separate engine drive may be installed in lieu of the conventional power take-off coupling. Addition of an emergency power-pack option allows the operator to lower the bucket if primary power fails. This emergency system includes a battery-operated combination pump, motor, and reservoir, plus an automatic brake to lock the arms. Several other options are also available to permit you to use power tools at the bucket level on the Bronco 83. To permit the use of pneumatic tools, Holan offers a compressed air line installed within the arm. A special valve to tap the hydraulic system is also available if hydraulic tools are desired. And, Holan equips the Bronco 83 with a motor-generator set to supply 110-volt, a-c power at the bucket for conventional electric tools. You choose the combination which fits your requirements.

For extra operating convenience and safety, include a remote signal system and engine start/stop circuit mounted at the bucket as another option when selecting your Holan Bronco 83.

Built-in ruggedness, dependability, and quality in combination with the numerous available options make the Bronco 83 elbow the outstanding articulating arm aerial device for your maintenance crews. Call your Holan representative now and let him help you tailor a new Bronco 83 to your needs. Or, write directly to: Holan, Division of The Ohio Brass Company, 4100 West 150th Street, Cleveland, Ohio 44135.

"Rugged enough to carry 300-pound payloads to 36-foot working heights, yet compact enough to maneuver in and out of tight spaces." That's the way many owners describe Holan's light-duty Bronco 83 elbow.



Holan's Bronco 83 fits on a chassis, as small as one ton, may be rotated in a continuous 360 degree circle in either direction, and requires no stabilizer jacks in operation. Numerous optional features let you tailor a Bronco 83 to fit your maintenance requirements.

Arrester protection of rotating machinery can be increased by wave-sloping capacitors

The dry insulation of most rotating electrical machinery, such as motors and generators, is particularly vulnerable to steep-front voltage surges. This danger also exists in relation to dry-type transformers in which the coils are not immersed in insulating oil. The short-time strength of both turn-to-turn insulation and insulation-to-metal frames is less in rotating machinery or other dry-insulated equipment than in oil-type transformers. Protective systems installed to prevent damage from overvoltage surges must effectively limit both the voltage stresses from conductors to machine iron and those developed between turns of the machine's coils.

The rapidly rising front of a voltage surge applied to the terminal of motor or generator coils penetrates the winding as a traveling wave with a velocity determined by the impedance characteristics of the coil. The voltage differential between turns at some instant can be very great, since certain turns of the coil may be a zero potential in respect to the frame at the same time other turns approach the maximum voltage of the surge.

The basic principle applied in protecting the turn-to-turn dry insulation of rotating machinery is to decrease the rate of rise of the voltage front of the incoming surge. Wave sloping is accomplished by incorporating capacitance and inductance into the circuit as shown in Figure 1. Under these conditions the capacitance may be furnished by a capacitor or may be the inherent capacitance of a cable-type line, while the inductance may be a coil, a reactance, an adjacent transformer, or the line itself. The arrester A1, installed for overvoltage protection, is the standard distribution, intermediate, or station-class arrester normally used to protect oil-immersed transformers.

Insulation of the conductors from the iron frame is still endangered, however, by the voltage crest which can occur across the wave-sloping capacitor. Therefore, common practice is to limit this overvoltage condition by installing a second arrester with special low sparkover characteristics in parallel with the capacitor at the terminal of the equipment. Figure 2 shows this basic circuit for protecting rotating machinery. Figure 3 illustrates alternate methods of combining low sparkover arrester for overvoltage protection with various wave-sloping expedients.

The low sparkover Ohio Brass station-class arresters specifically recommended for application in parallel with wave-sloping capacitors are the Thorex Dynagap Type RM-A. RM-A arresters are assembled with specially selected internal components and are laboratory tested for full confirmation of their response characteristics. Voltage ratings for the RM-A arresters are from 3 through 27 kv, line-to-ground. Construction of Thorex RM-A arresters in the porcelain-top design as shown in Figure 4 reduces required mounting clearances and permits shorter connections to protected apparatus.

As an alternative low sparkover arrester, where durability is less of a factor, the lower cost Multirester DA-RM is also suitable for this application. As in the station-class RM-A arresters, the DA-RM Multiresters have a significantly lower sparkover level than standard models at each corresponding kv rating from 3 through 12 kv, line-to-ground. DA-RM Multiresters are identical in appearance to standard models and all optional accessories except the external air gap are applicable.

In operation the standard arrester A1 limits the voltage of the incoming surge, while the combined effect of the inductance and capacitance limits the rate of rise of the surge voltage at the machine terminal. The low-sparkover arrester A2 limits the magnitude of the voltage from the machine terminal to the grounded frame.

It is customary to determine circuit characteristics that will slope the voltage front of incoming surges so that crest is reached in 10 microsec or more. Steeper fronts are probably safe with modern electrical machinery, but this conservative figure has been accepted in the interests of both safety and standardization. Various combinations of inductance and capacitance determine the degree of wave sloping attained in the rate of rise of the voltage surge. Common figures for an operating voltage range of 2400 to 6900 specify a capacitance of one-half microfarad and a lumped series inductance of about 175 microhenries, when using valve-type lightning arresters.

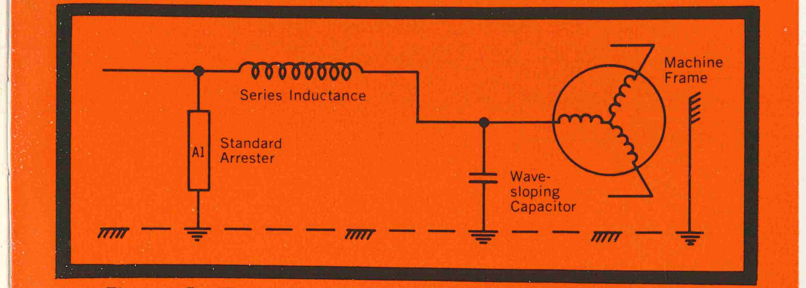

Series Inductance
Machine Frame
A1
Standard Arrester
Wave-sloping Capacitor

Figure 1—Principle of wave-sloping circuit connections.

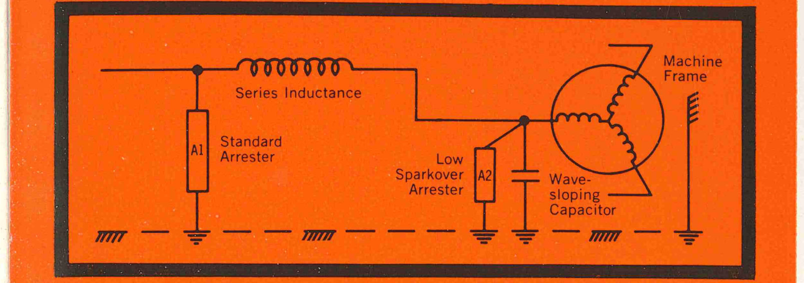

Series Inductance
Machine Frame
A1
Standard Arrester
Low Sparkover Arrester
A2
Wave-sloping Capacitor

Figure 2—Basic circuit for protecting rotating machinery.

WAVE-SLOPING THROUGH THE ADDITION OF SERIES INDUCTANCE

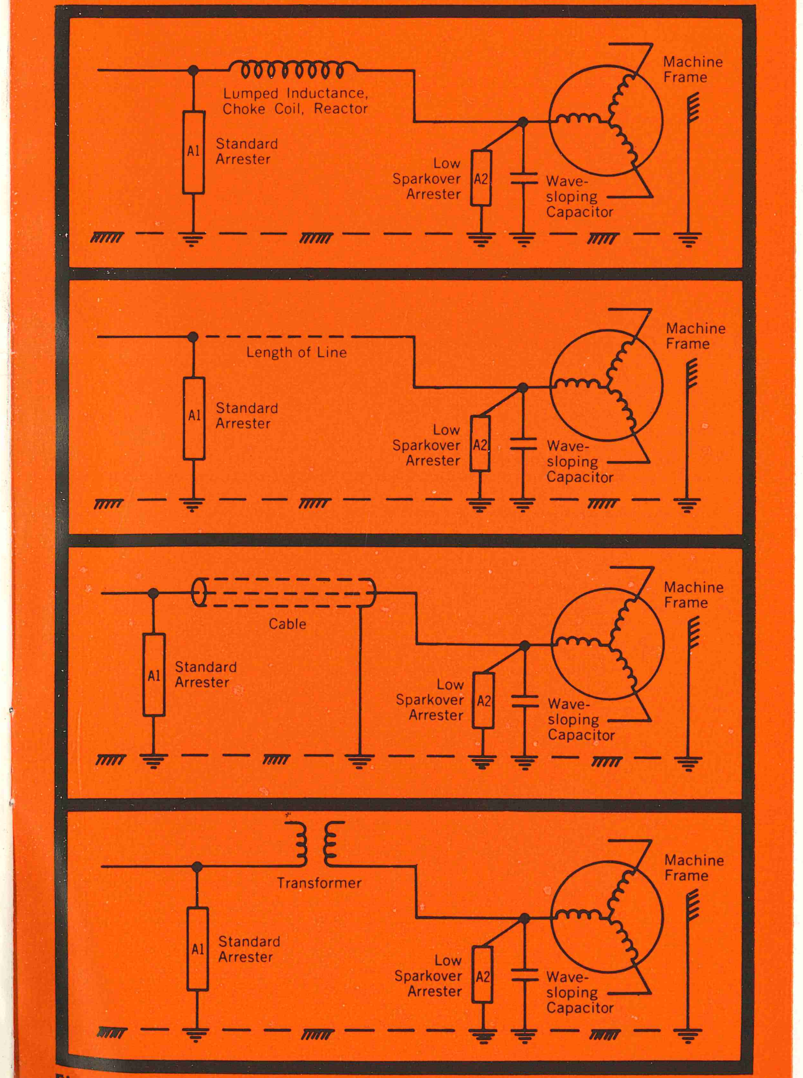

Lumped Inductance, Choke Coil, Reactor
Machine Frame
A1
Standard Arrester
Low Sparkover Arrester
A2
Wave-sloping Capacitor
Length of Line
Machine Frame
A1
Standard Arrester
Low Sparkover Arrester
A2
Wave-sloping Capacitor
Cable
Machine Frame
A1
Standard Arrester
Low Sparkover Arrester
A2
Wave-sloping Capacitor
Transformer
Machine Frame
A1
Standard Arrester
Low Sparkover Arrester
A2
Wave-sloping Capacitor

Figure 3—Alternate methods of obtaining wave-sloping protection.

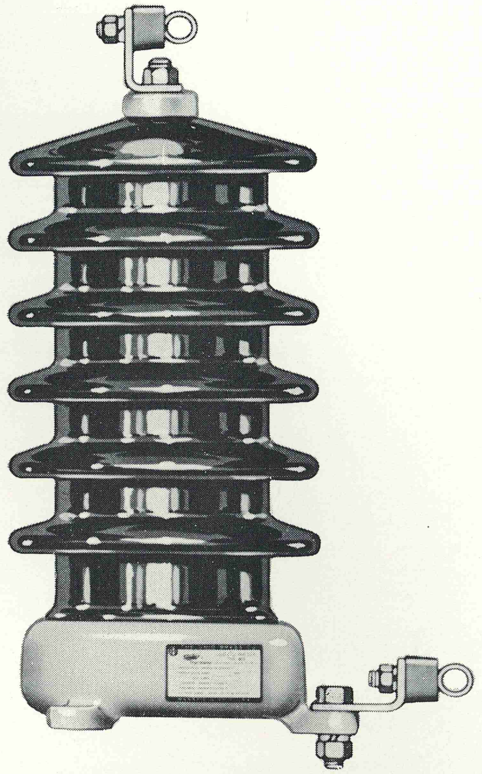
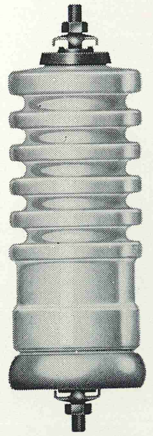


Figure 4 — Thorex Dynagap RM-A arrester has low, controlled sparkover characteristics for increased protection of dry insulation.

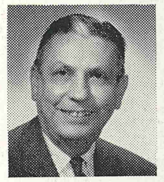
Figure 5—Distribution class Multirester DA-RM has low sparkover characteristics and reduced IR discharge voltages.



OHIO BRASS MANAGEMENT REPORT

It's the iceberg below that makes the difference

BY ROGER A. BLACK
PRESIDENT, OHIO BRASS COMPANY

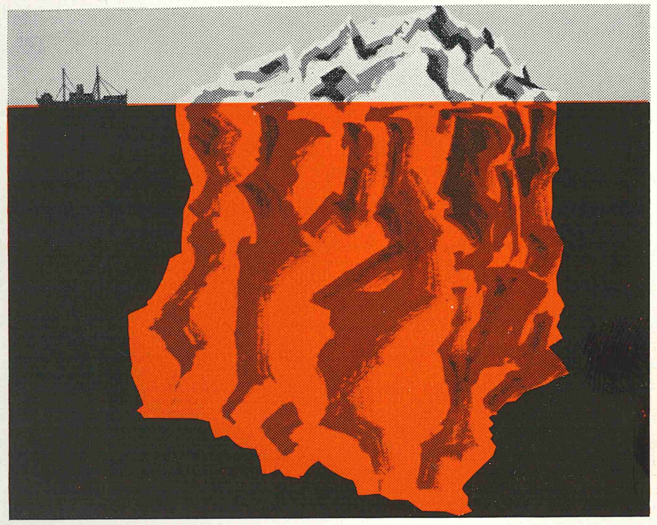


Granted that every executive doesn't know everything about his company, I still had some pleasant surprises in reading the January issue of *Hi-Tension News*, the publication which Ohio Brass sends to its utility customers and prospects. The issue describes the O-B High Voltage Laboratory in detail. Of course, the four-million-volt, all-weather surge generator and the new voltage divider get considerable attention. But it goes beyond the glamour equipment and crash testing programs to talk about behind-the-scenes activity that has both human and technical interest.

IT DESCRIBES A BRAND-NEW oscilloscope being benched and rewired simply because there are no available 'scopes that meet the present needs of the laboratory for measuring conditions that have never been measured before. *Hi-Tension News* notes the presence of a full-time machine shop in the laboratory basement. Often a prototype under test has to be modified on the spot so that an expensive test set-up doesn't stand idle.

THE ISSUE DISCUSSES the problem of finding personnel to maintain our five surge generators. Just like suitable oscilloscopes, they aren't available in the market place. We must train our own, and we need a graduate engineer to supervise the job.

IN OBSCURE CORNERS of the laboratories all kinds of seemingly simple tests go on . . . insulators live in a highly polluted atmosphere with leakage currents being continuously recorded . . . an isolation chamber tests hardware ability to stand up in a highly corrosive atmosphere.



WE EVEN HAVE our special brand of photography with a laboratory staff photographer who has developed special techniques for recording flashovers so that our customers can see in photographs what goes on when their projects are tested . . . better than their own eyes can do the job.

OUR HIGH VOLTAGE LABORATORY has been compared to an iceberg. Showing above the surface are spectacular equipment and glamourous testing. But it's the eight-ninths below the surface that contributes even more to meaningful results. If you would like to know more about the iceberg below, I'll be glad to send you a copy of our January *Hi-Tension News*.

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OHIO BRASS

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